Electronic supplementary information (ESI)

Nitrogen doped carbon dots as fluorescence ON-OFF-ON sensor for parallel detection of copper (II) and mercury (II) ions in solutions as well as in filter paper based microfluidic device

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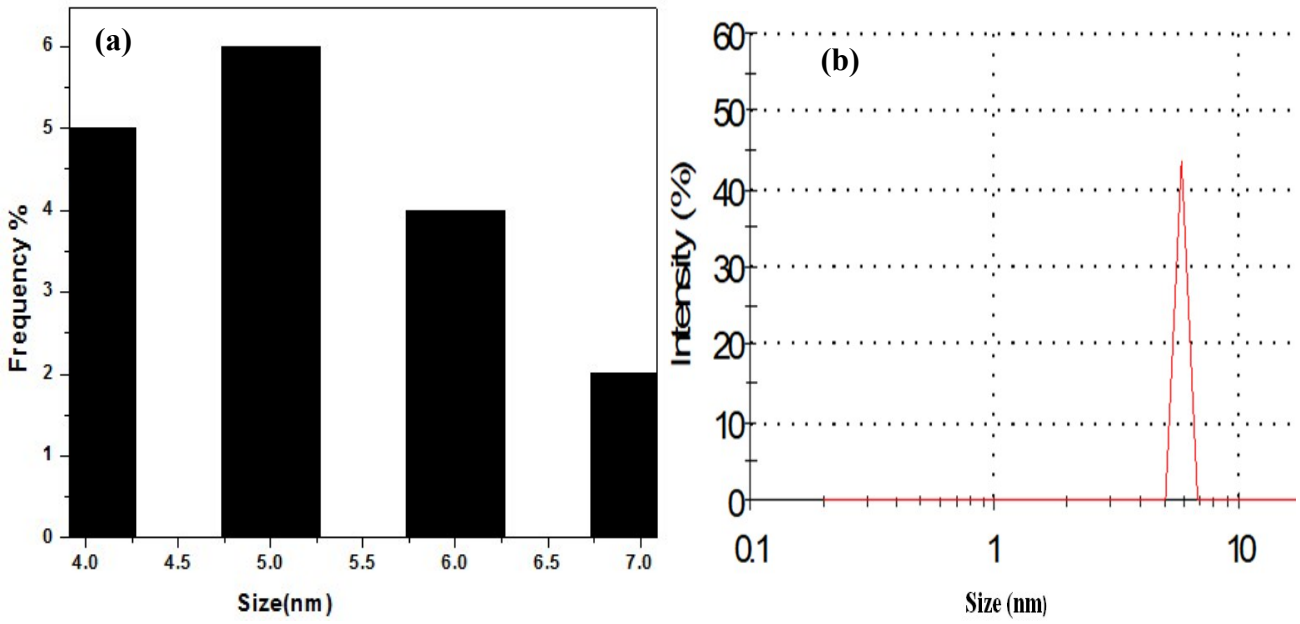

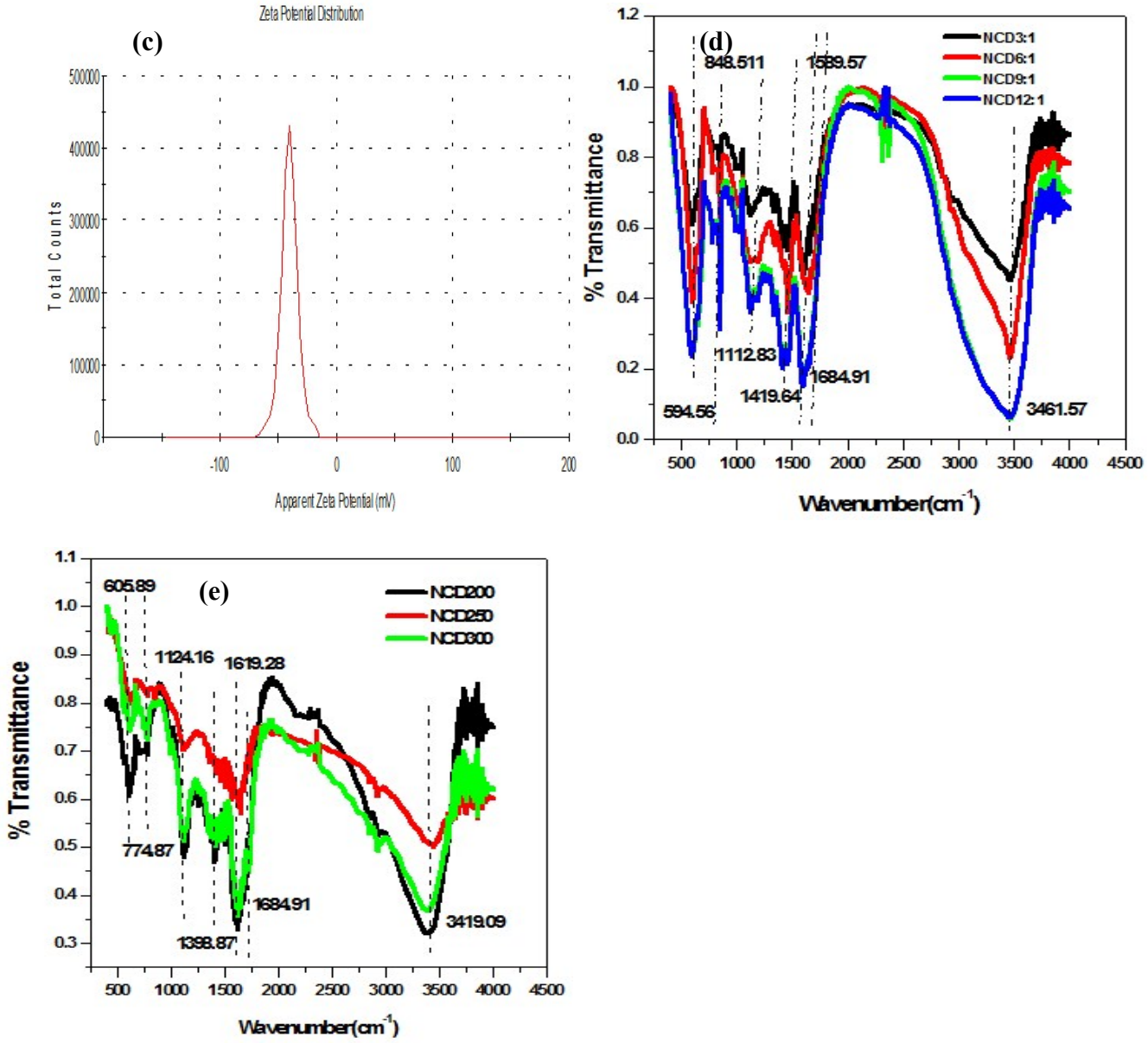

Figure S1.(a) Particle size disributuionof NCDs from TEM images(b) Particle size distribution profile from dynamic light scattering (DLS) measurement of NCDs (c) Zeta Potential measurement of NCDs (d) FT-IR spectra of NCDs (different mol ratio, 3:1, 6:1,9:1, 12:1 of urea and EDTA.)(e) FT-IR spectra of NCDs (different temperature, 200, 250, 300^{o}C)

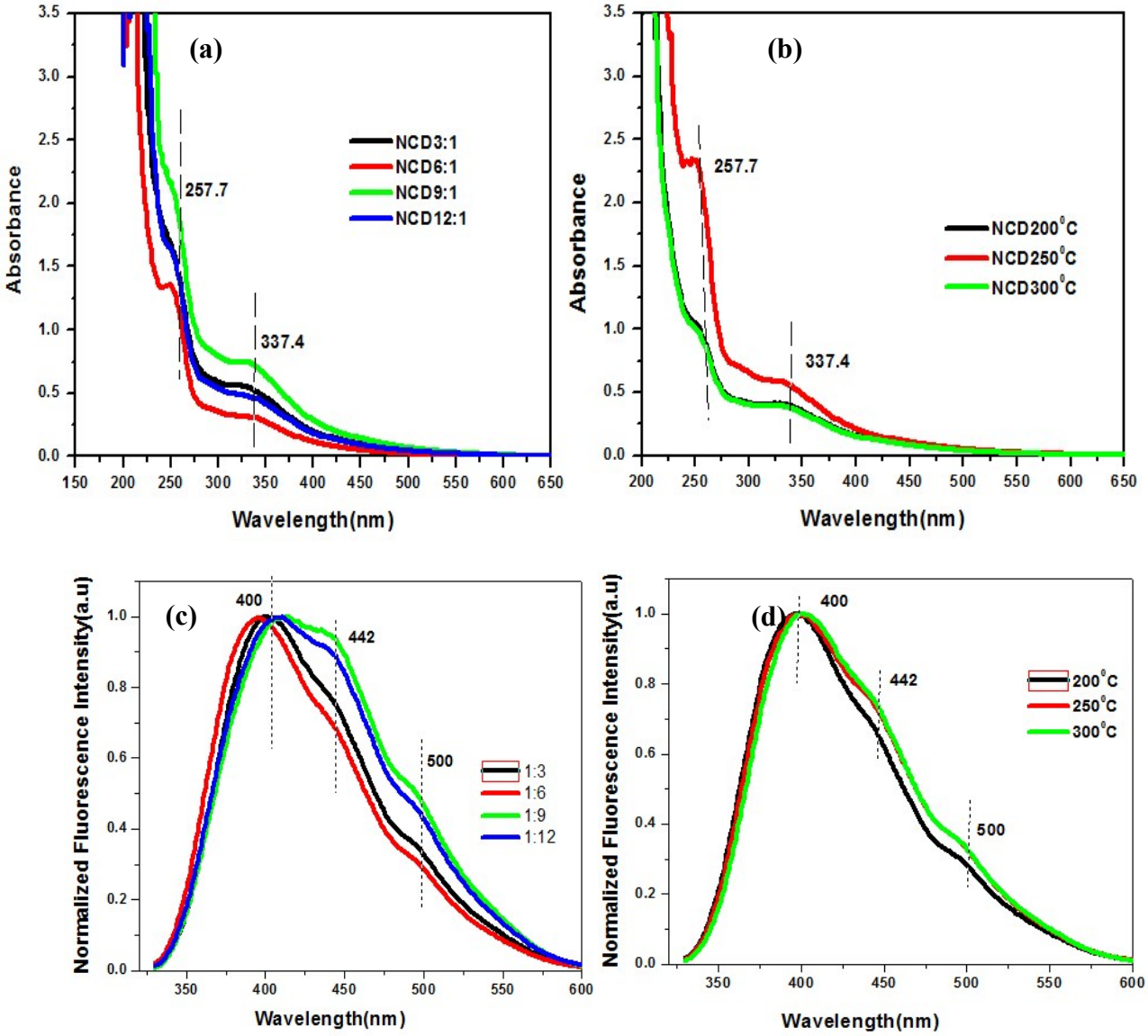

Figure S2.(a) UV- visible spectra of NCDs (different molar ratio, 3:1, 6:1,9:1, 12:1 of urea and EDTA.) (b) UV-visible spectra of NCDs (different temperaure, 200, 250, 300^{o}C) (c) Normalized fluorescence spectra ofNCDs (different molar ratio, 3:1, 6:1,9:1, 12:1 of urea and EDTA, λ_{ex} =320nm) (d) Normalized fluorescence spectra ofNCDs(different temperaure, 200, 250, 300^{o}C, λ_{ex} =320nm)

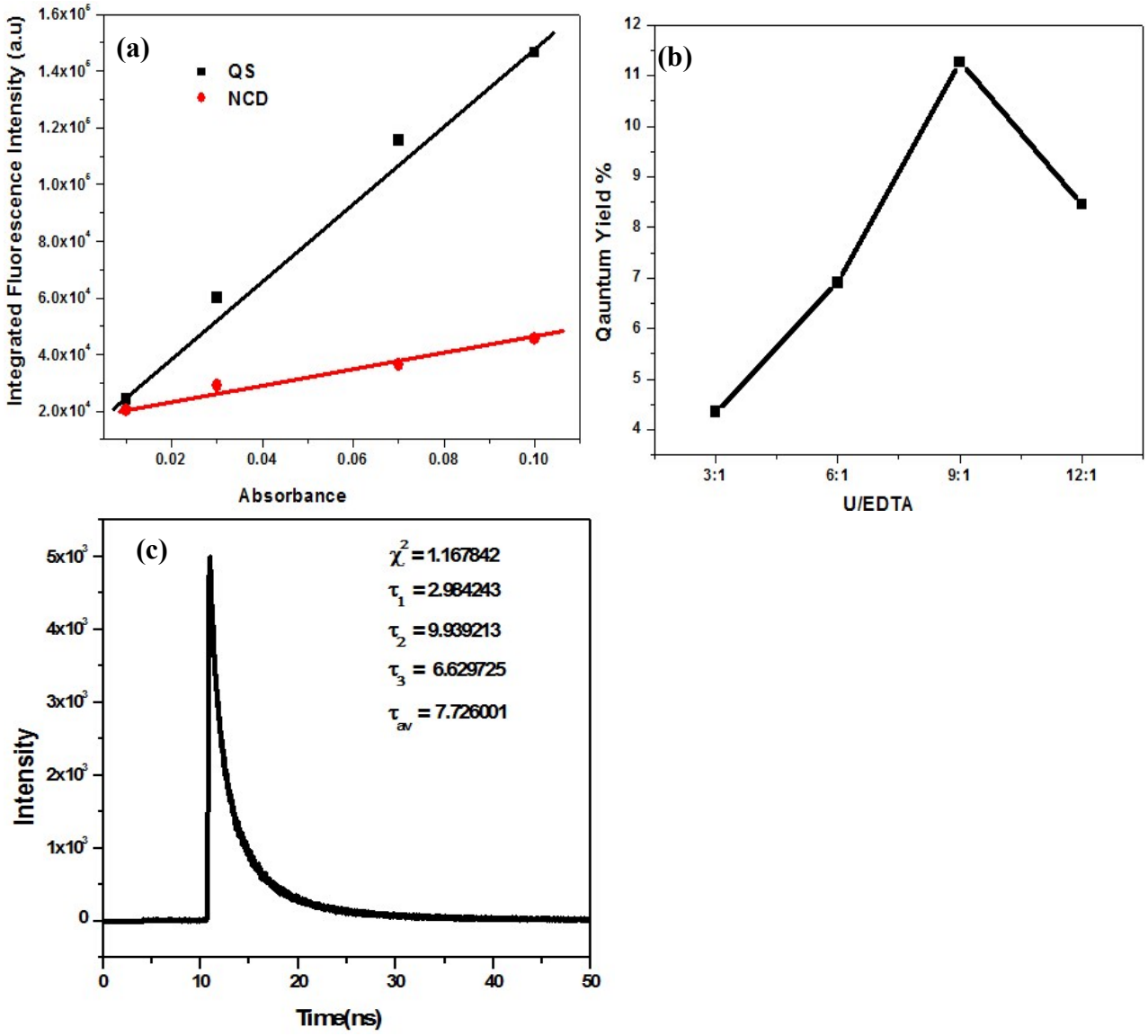

Figure S3.(a) Qautum yield determination of NCDs (b) variation of the qauntum yield of NCDs (different molar ratio,3:1, 6:1,9:1, 12:1 Urea:EDTA) (c) TRPL life time profile of NCDs.(inset: fluorescence life time table)

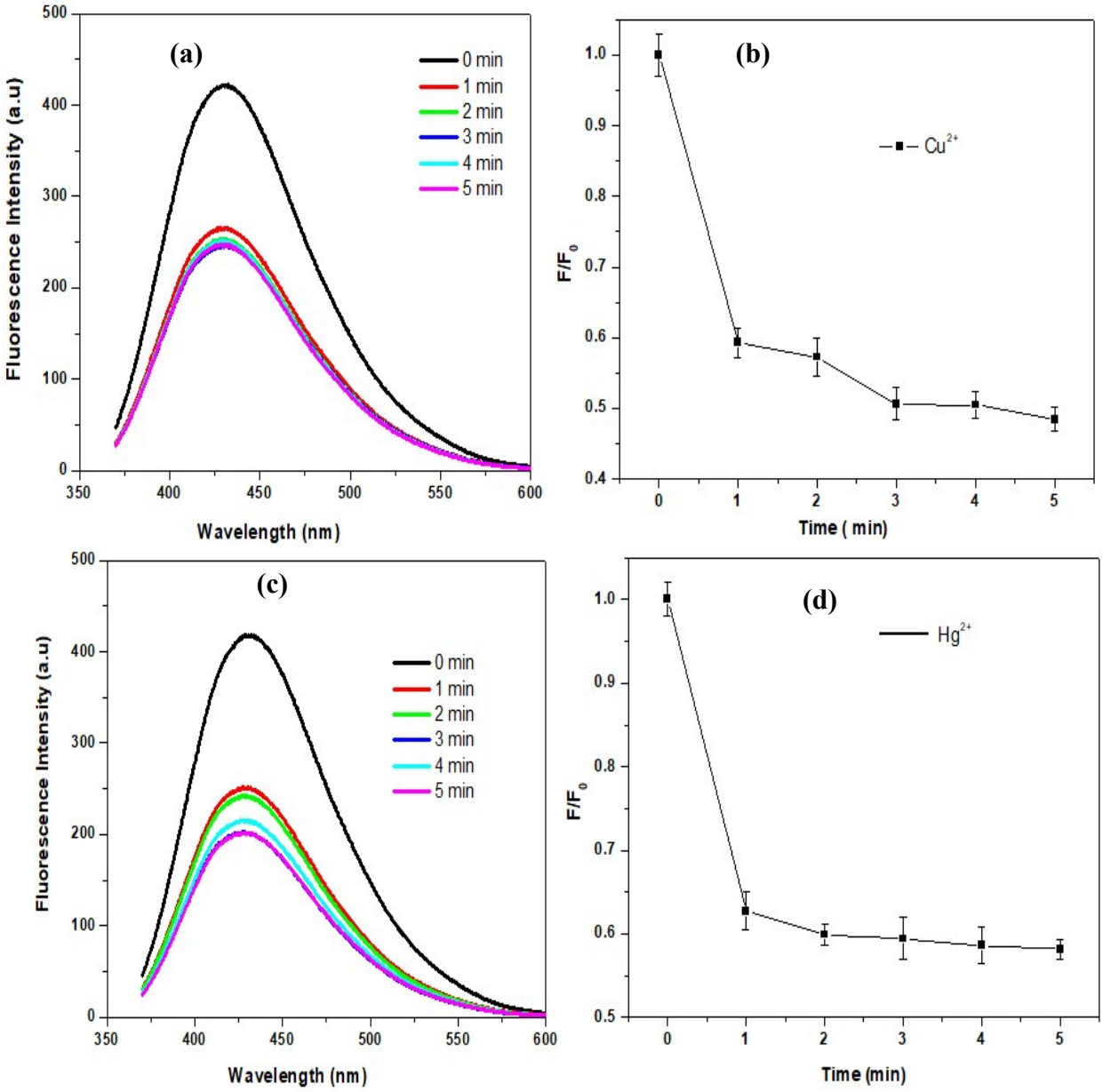

Figure S4. (a) Fluorescence emission responses of aqueous NCDson addition of Cu^{2+}(25 μM) ions with variation of time(λ_{ex} = 360 nm) (b) Plot of F / $F_o$vs time, error bars are derived from three independent sets of experiments. (c) Fluorescence emission responses of aqueous NCDs on addition of Hg^{2+} (25 μM) ions with variation of time (λ_{ex} = 360 nm) (d) Plot of F / $F_o$vs Hg^{2+}time, error bars are derived from three independent sets of experiments.

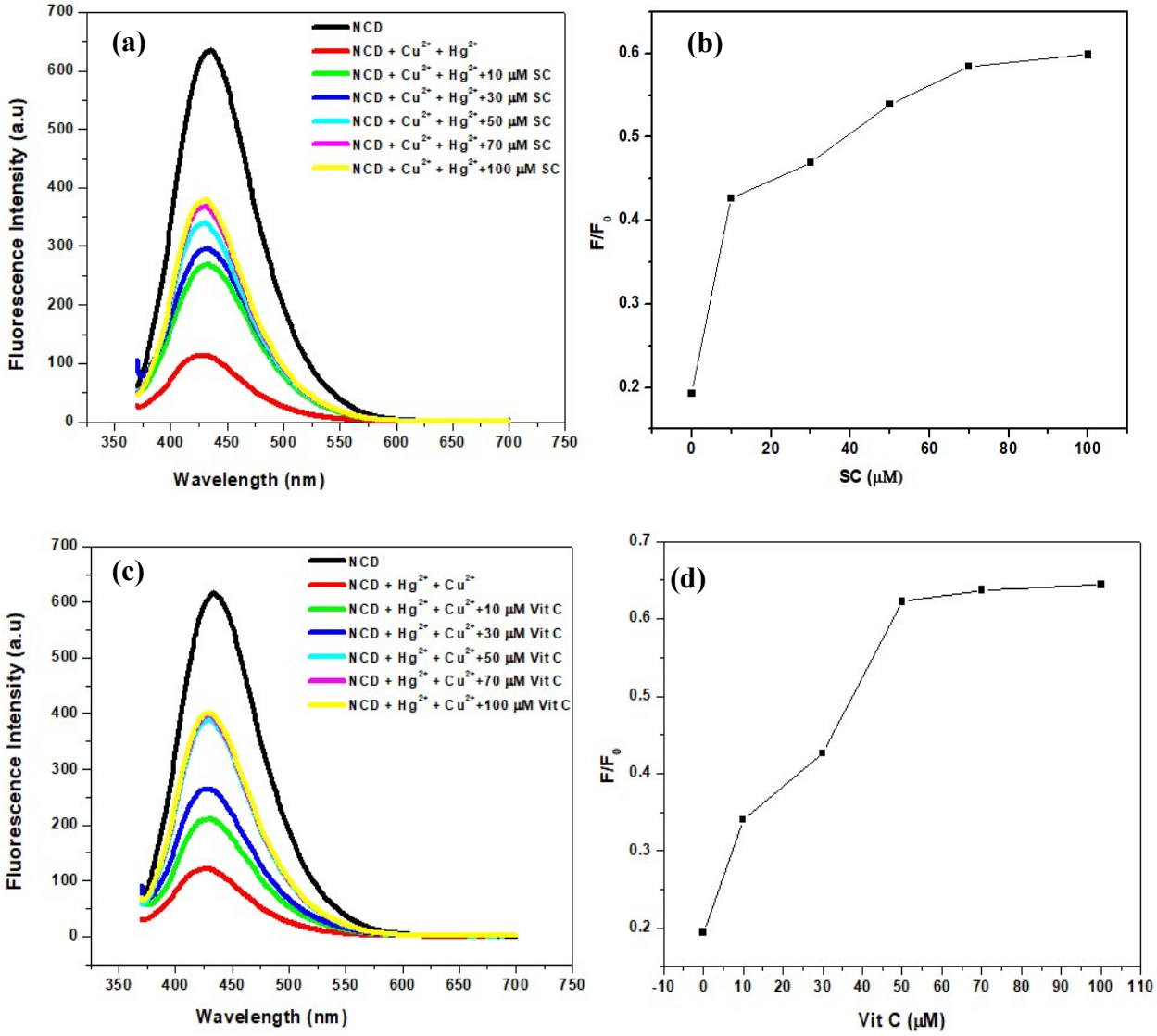

Figure S5. (a) Fluorescence emission spectra of NCDs before and after addition of mixture of Cu^{2+}+ Hg^{2+} ([M^{n+}] =50 µM, 5 µL + 5 µL)and follow by addition of different concentration of trisodium citrate (SC)(λ_{ex} = 360 nm) (b) corresponding relative fluorecence ratio of the NCDs with variation of the concentration of SC (c) Fluorescence emission spectra of NCDs before and after addition of mixture of Hg^{2+} + Cu^{2+} ([M^{n+}] =50 µM, 5 µL + 5 µL) and follow by addition of different concentration of vitamin C (Vit C) (λ_{ex} = 360 nm) (d) corresponding relative fluorecence ratio of the NCDs with variation of the concentration of Vit C.

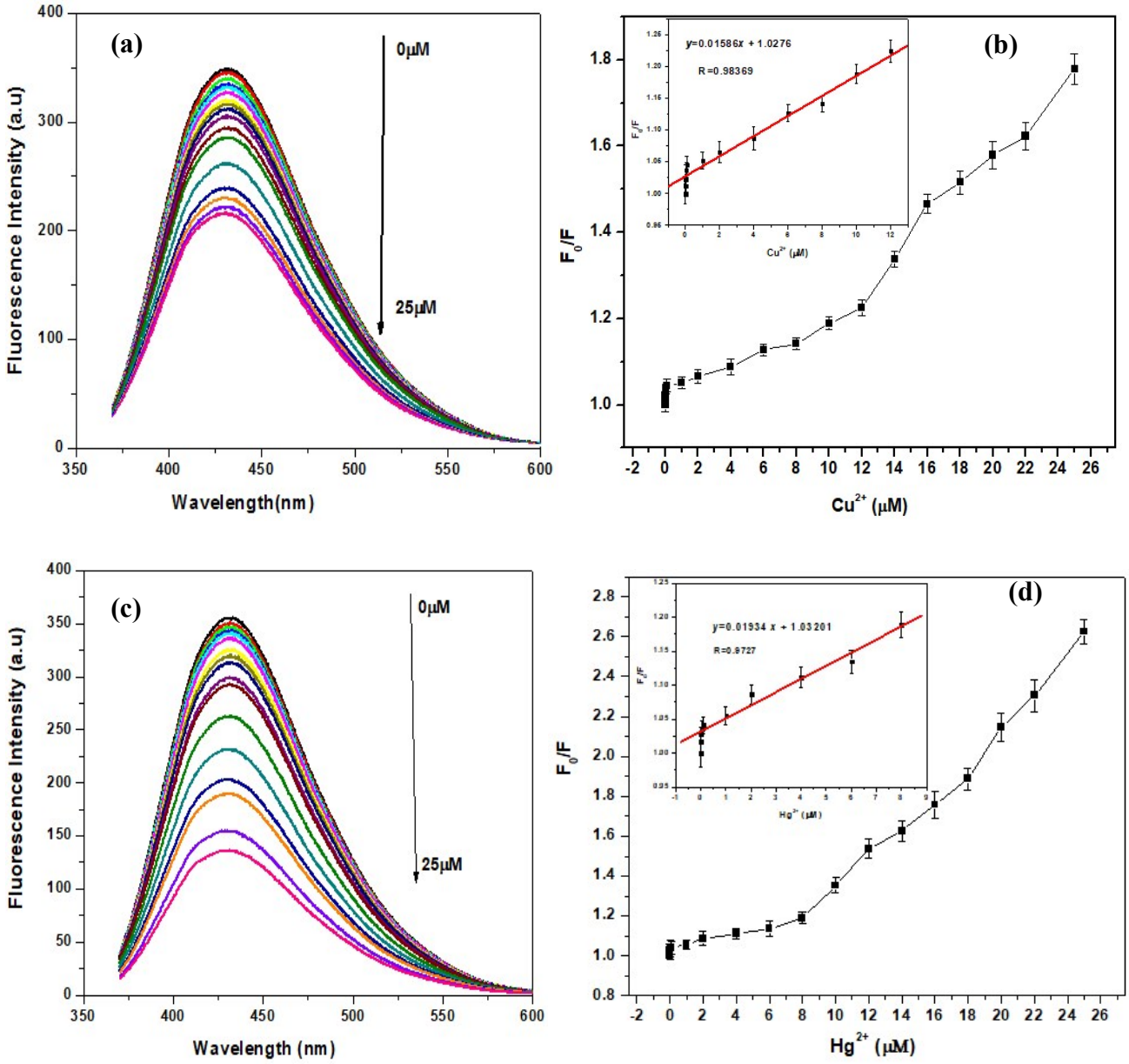

Figure S6. (a) Fluorescence emission responses of aqueous NCDs on addition of Cu^{2+}(0-25 μM) ions (in tap water)with excitation fixed at 360 nm wavelength (b) Plot of F_o/F vs Cu^{2+} concentration (0-25 μM), error bars are derived from three independent sets of experiments.(c) Fluorescence emission responses of aqueous NCDs on addition of Hg^{2+} (0-25 μM) ions (in tap water)withexcitation fixed at 360 nm wavelength(d) Plot of F_o/F vs Hg^{2+} concentration (0-25 μM), error bars are derived from three independent sets of experiments.

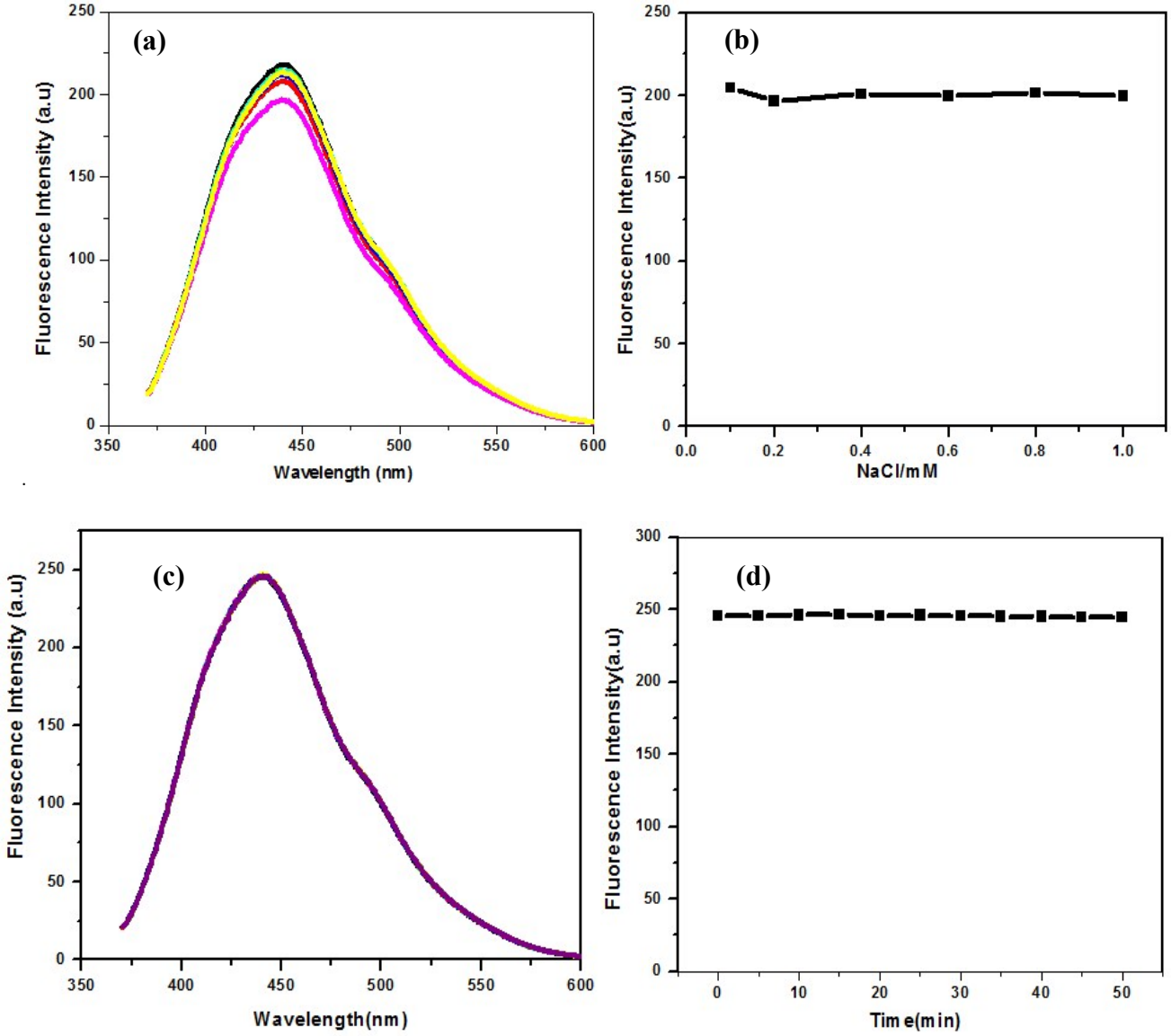

Figure S7.(a) Fluorescence intensity of the NCDs towards ionic strenght (NaCl) (0.1 to 1mM)(λ_{ex} = 360 nm)(b) corresponding fluorescence intensityversus ionic concentration plot (c) Fluorescence intensity of the NCDs with time(λ_{ex} = 360 nm)(d) corresponding fluorescence intensity plot.

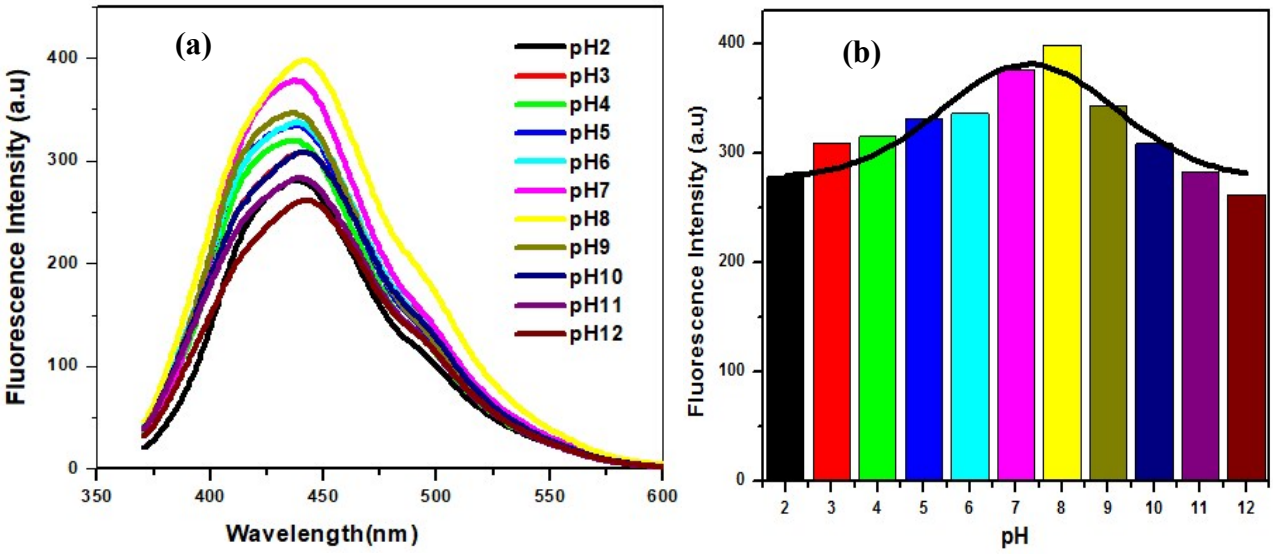

Figure S8. (a) Fluorescence spectra of NCDs at pH(2-12)(λ_{ex} = 360 nm) (b) corresponding bar diagram

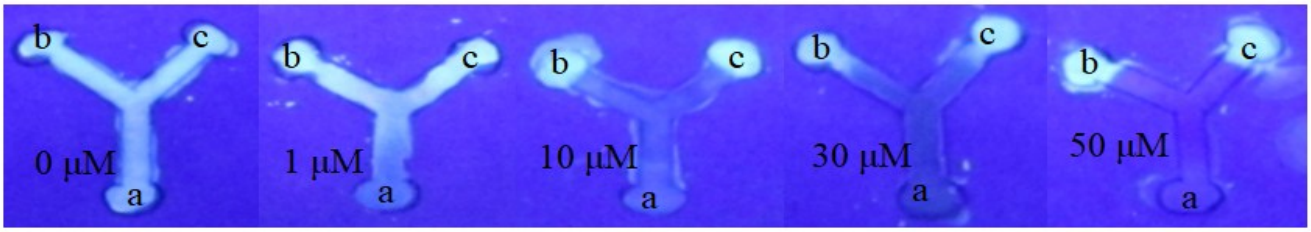

Figure S9. Digital photograph of fluorescence sensing of different concentration of Hg^{2+}+Cu^{2+} mixture (0 µM,1 µM, 10 µM, 30 µM and 50 µM) with filter paper based microfluidic device (10 µL of NCDs is drop casted on area **a** which flow to area **b and c (**capillary flow through the hydrphophic channels created by wax). Followed by addition of (5 µL + 5 µL) different concentration of Hg^{2+}+Cu^{2+} mixture (total concentration,0 µM, 1 µM, 10 µM, 30 µM and 50 µM). Area **b** and **c** is loaded with vitamin C(VitC) and trisodium citrate(SC) respectively.The photogarph are captured under 365 nm UV lamp.

Table S1. Fluorescence Hg^{2+} or Cu^{2+} sensing efficiency comparison for different materials

Fluorescence materials	Analyte	Detection limit	Linear range	Reference
DNA-AuNP	Hg^{2+}	25nM	0.05-2.5μM	S1
CN-DPA	Cu^{2+}	20μM	0- 5 μM	S2
CDs	Cu^{2+}		10 -90 μM	S3
CDs	Cu^{2+}	20nM	0.0 -30 μM	S4
N-CDs	Hg^{2+}	0.23 μM	0-25μM	S5
NCDs	Hg^{2+}	0.65 μM	0.001-5μM	S6
NCDs	Hg^{2+}	6.2 nM	0.001(1 nM)- 8μM	This Work
NCDs	Cu^{2+}	2.304nM	0.001(1 nM)-22 μM	This Work

References

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